LOESS-DEPOSITING WINDS IN LOUISIANA

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The data on which this paper is based were accumulated from field work on the two loess belts of Louisiana together with a few examinations of loess at Vicksburg and Natchez, Mississippi. Practically all the evidence points to an eolian origin for the southern loess. Assuming this origin, it appears from two lines of evidence, namely the amounts and thickness and the chemical composition of this loess, that the principal depositing winds were westerly and southerly.

THE LOESS

The loess in Louisiana is of brownish to gray-brown colors and shows the usual vertical cleavage. For the most part it overlies Lafayette and Columbia sandy and gravelly materials and Pleistocene clays which are usually correlated as Port Hudson. It was deposited on an eroded surface, hilly in most places where the loess overlies the Lafayette and Columbia formations, and rolling to undulating where it overlies the clays (Fig. 1). There are two loess belts fringing the Mississippi lowlands, extending nearly to the Gulf. The eastern belt, beginning about 15 miles south of Baton Rouge, about 80 miles from the Gulf, with a width of about 15 miles, widens to the northward to a width of perhaps 40 miles in Mississippi. This belt continues northward through Tennessee to the Ohio River with practically no interruptions except at stream valleys. The western belt begins near Lafayette about 40 miles from the Gulf and extends to the Red River valley, a distance of about 50 miles, with an average width of 8 to 10 miles. Ten miles to the north the loess again appears in an island-like area, the Avoyelles Prairie, of about 80 square miles. About 40 miles northeast the loess belt again reappears at Sicily Island, from which it extends northward into Arkansas in a belt known locally as the

Bayou Macon Hills, with a width varying from 5 to 15 miles. The western loess belt is seen to be somewhat longer but much narrower than the eastern belt.

These belts in Louisiana show contrasts in thickness and in the outlines of their margins away from the Mississippi. The eastern belt, beginning with a thickness of from 10 to 12 feet, thickens to

FIG. 1.—Loess overlying a buried hill of red Lafayette materials. The arrows point to the contact. West Feliciana Parish, Louisiana.

the northward to about 15 to 20 feet at Bayou Sara, 35 miles to the northward; at Vicksburg it is from 30 to 40 feet thick. The western belt, with about the same thickness at the south, thickens but little to the north, being but 12 to 15 feet thick in the Bayou Macon Hills, nearly 200 miles to the north. The eastern belt in Louisiana ends rather abruptly at the Amite River. On the west side of this stream the observed thickness is about 6 feet, while across the valley two miles to the eastward the loess is much thinner and sparsely developed. On the other hand, the western belt thins so gradually that its western limits can only rarely be observed. The

two belts correspond in having the thickest loess near the Mississippi lowlands.

Here, as in most places elsewhere, the loess shows the characteristic uniformity in size of particles. There are no available mechanical analyses of the lower part of the loess, but several analyses of lower subsoils show that about 70 per cent ranges in size from $\frac{5}{100}$ to $\frac{1}{100}$ mm. in diameter and about 20 per cent is below this diameter. The remainder is composed of particles but slightly larger than $\frac{5}{100}$ mm. in diameter. In general the loess particles of Louisiana seem to be more rounded than those farther north, so far as the writer can judge from the examination of half a dozen samples from Iowa and Illinois. This difference is doubtless to be explained by the fact that the southern loess particles have been subjected to long transportation by the Mississippi. In the main body of the loess an examination of perhaps 500 exposures shows little if any stratification, although here and there there are faint indications of such structure. For example, the snail shells which are abundant locally show in a few places a rude horizontal alignment and lie in thin dark streaks suggesting buried soils. In a few places dark bands never more than a few inches long and probably due to iron and manganese coatings suggest that these substances have accumulated along bedding planes. A sharp contact between the loess and the underlying materials has never been observed, but rather there is a transition zone 3 to 20 inches in thickness. The transition is most indefinite between the loess and underlying clays, for there is more or less similarity in texture and in some cases in color. Where Lafayette and Columbia sandy materials underlie the loess, there is in places a "feathering" of the one into the other and in places very faint stratification.

THE ORIGIN

Two problems are involved, (1) the source of the loess materials, a problem with which this paper does not deal directly, and (2) the secondary or the depositing agents. Since the loess belts follow only the Mississippi lowlands and do not extend up the tributaries, it is clear that there is a genetic relation between the river from Cairo southward and the loess. The Mississippi doubtless carried

the loess materials, and the agent of final loess placement on the uplands adjoining the river narrows either to water deposition or to winds carrying materials from the lowland.

The explanation of southern loess as wind-blown dust not only presents the fewest difficulties but is distinctly supported by most of the loess features. The smallness of grains can be explained by the weakness of wind transportation, for, according to the experiments of Udden, only dust particles with diameters of .18 mm. and less are readily borne by ordinary winds.[1] We have noted that about 70 per cent of the loess is composed of silt particles from .05 to .01 mm. in diameter and that the mechanical composition is notably uniform. The practical absence of coarse particles is, of course, explained by the inability of ordinary winds to carry them. Udden thus explains the small percentages of very fine particles.[2]

The writer suggests another reason for the relatively small percentages of very fine materials (clays) in the loess. Observations on clay and silt plowed fields in Kansas during dry seasons showed that more dust blows from the coarser silt soils than from the clay soils. The reason apparently is that, during a dry season, the clays bake more than the silts and so offer more resistance to the winds. According to this conclusion, if the Mississippi upon subsiding left areas covered here with silt and there with clay, the winds would carry a larger proportion of silt than of clay.

In a large river like the Mississippi it would seem impossible for the water to deposit its sediment with practically no stratification, even if the water carried only loessial materials, for the loess contains from 5 to 10 per cent of fine sand, and in places this coarser material would be segregated. The loess materials carried by the Mississippi were in large part carried from drift regions to the northward and, even granted that the drift furnished only fine materials, the streams south of the glaciated region, such as the Arkansas, Yazoo, and Red rivers, were doubtless contributing their sandy loads, so that the Mississippi could not have carried only a loessial

[1] *Journal of Geology*, II (1894), 323.

[2] "The finest materials carried by the air are not deposited in so great a proportion with the coarse materials as they would be if the atmosphere carried a greater load. The finest materials settle only in extreme calms" (*ibid.*).

load to the Louisiana region. Furthermore, such a river in flood would necessarily back up the tributaries and loessial materials would be deposited along the tributaries in contrast with the actual fairly straight margin where it crosses a tributary.

So far as the structure of the loess is concerned, it might have accumulated in lakes or have been deposited by winds, but in the hundreds of miles of loess belts below Cairo there are no restraining barriers which would impound lakes. Moreover, lakes in which 10 to 50 feet of loess accumulated must have existed long enough for deltas to have been built and shore lines developed, for in such temporary lakes as the Red River raft lakes of Louisiana one may find well-developed shore lines around these nearly drained lakes. No such shore lines have been seen in the Louisiana loess areas and none to the writer's knowledge have been reported elsewhere in the Lower Mississippi Basin.

The relations of the loess to the underlying buried Lafayette-Columbia sandy hills near the Mississippi strongly suggest an eolian origin (Fig. 1). The absence of truncation of these buried hilltops, the very faint or frequent absence of interstratification of loess and sand at the contact, all point to a weak depositing agent such as wind. The greater thickness of loess near the Mississippi is not inconsistent with an eolian origin, for the dust-laden winds blowing from the lowlands to the uplands would have their velocity checked and so drop part of their load near the river. The work of Shimek shows that the loess fossils in this region, mostly snails, belong to a land fauna, there being "no species which are aquatic or even semi-aquatic,"[1] and the virtual absence of a water fauna is equally significant.

DIRECTIONS OF LOESS-BEARING WINDS

Assuming the eolian theory of loess in Louisiana, there are three lines of evidence available as to the directions of loess-depositing winds, namely: (1) the width and thickness of the loess belts on either side of the Mississippi, (2) the composition of the loess, and (3) the thickness of loess on some isolated areas which were exposed to the sweep of winds from many directions.

[1] *Am. Geologist,* XXX, 282.

1. The greater thickness and width of the eastern loess belt have been noted by many observers and usually explained as due to stronger and perhaps more persistent westerly depositing winds. From a rough calculation based on field notes the writer estimates that the loess in Louisiana below the Mississippi state line includes about 4 cubic miles, while the corresponding portions of the western belt includes only .8 of a cubic mile, or, roughly estimating, there is about five times as much loess in the lower eastern belt as in the corresponding portions of the lower western belt. These contrasts point to the greater work of westerly as compared with easterly winds.

2. The same conclusion seems to be indicated by the composition of loessial soils in the two belts. While the analyses are of soils and subsoils only, it is believed that the *range* of their compositions corresponds to that of the underlying loess, since the soils have been subjected to practically the same weathering processes over both belts. Taking the composite soil analyses of the eastern loess belt below the Mississippi state line and the corresponding portions of the western belt, we have the following data:[1]

	Number of Analyses	Lime (Lbs. per Acre)	Potash (Lbs. per Acre)	Phosphoric Acid (Lbs. per Acre)
Eastern belt	21	5,540	8,500	980
Western belt	14	6,000	8,920	1,800

The lime and potash are slightly higher in the western belt, and the phosphoric acid decidedly so. So far as can be determined by a microscopic examination, the lime and potash occur in feldspars with diameters mostly $\frac{1}{100}$ mm. in diameter or less. Most of the phosphoric acid occurs in the very fine particles, the fine silts and clays, with diameters below $\frac{5}{1000}$ mm. These fine particles are difficult to study microscopically, and the writer has been unable to identify the phosphate-carrying minerals except for an occasional particle of apatite. However, the point to be emphasized in this connection is that the particles carrying lime, potash, and phosphoric acid are very small, and it is believed that the higher

[1] Analyses by I. Selecter, Soil Chemist, Louisiana State Agricultural Experiment Station.

percentages of these minerals in the western belt are due to a differential selection of wind load. The weaker easterly winds carried a relatively finer load than the stronger westerly winds, with the result that higher percentages of lime, potash, and phosphoric-acid-carrying minerals were deposited in the western loess belt.

3. The third line of evidence concerns the effectiveness of northerly winds as compared with southerly winds as loess-carrying agents. The Avoyelles Prairie (see Fig. 2) is an island-like area of

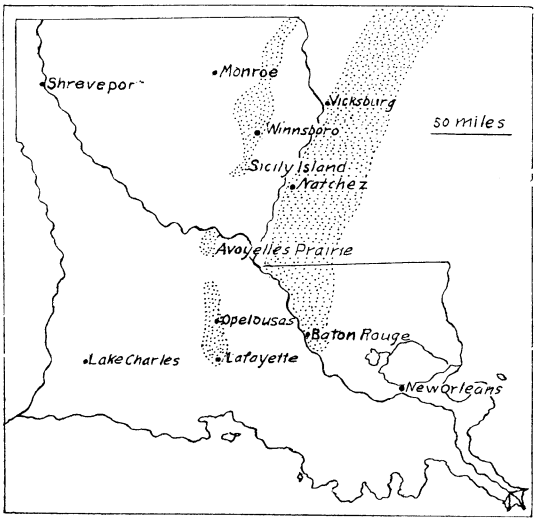

FIG. 2.—Map showing the loess belts (dotted) in Louisiana and Mississippi. (Loess in Mississippi after Mississippi Geological Survey.)

about 80 square miles, which is entirely surrounded by alluvium and capped by a layer of loess overlying Lafayette-Columbia and Port Hudson materials. The platform on which the loess rests is 10 to 15 feet above the alluvium in the two places where the top of the platform was observed. This relatively elevated area was exposed to the sweep of the winds from all directions, with no loessial soil within 10 to 30 miles, and it seems clear that the prevalent winds would deposit the thickest loess in a manner analogous to the drifting of snow in some regions. The loess-bearing winds from the south, for instance, would drop a portion of their load on

reaching the low elevation. If the elevation were of small area, there might also be an accumulation of dust on the lee side of the obstruction, as snow drifts on the lee side of a tight fence; but in this case the winds passed over several miles of low upland, and it seems probable that most of the heavy load would be deposited on the windward side and but little dust would be left to accumulate on the leeward side. The loess on the Avoyelles Prairie is about 12 feet thick at the southern end of the area and 6 to 7 feet thick at the northern end, a difference in thickness indicating southerly rather than northerly winds as the main depositing agents. No sections were observed which allow comparisons of thickness on the eastern and the western sides. About 40 miles east of north from the Avoyelles Prairie is Sicily Island, the southern extremity of the Bayou Macon Hills, which, as we have seen, is a loess-covered ridge extending from Arkansas into Louisiana. At the southern end of Sicily Island the loess is from 12 to 14 feet thick, and about 7 miles northward it thins to 7 to 10 feet. The evidence here is not so clear, for the dust may have accumulated on the lee side of the ridge from northerly winds, or it may have accumulated from the deposition by southerly winds at the southern side of Sicily Island. However, it seems that the thicker loess at the southern ends of both these elevations points to the greater effectiveness of southerly winds as loess-depositing agents as compared with northerly winds.

PRESENT WINDS

There is some interest in comparing modern wind directions to ascertain, if possible, whether the most effective modern winds in this region are at present westerly and southerly. Unfortunately no positive conclusions can be reached, because one cannot be sure that the average for so short a time as that for which we have records represents the modern wind directions, and, furthermore, the important elements of wind persistence and velocity are not given in the reports. Fig. 3 shows the average prevailing wind directions for the several months at New Orleans, Louisiana; Vicksburg, Mississippi; and Memphis, Tennessee, for periods of thirty-six, thirty-five, and thirty-five years respectively. The winds at Vicksburg and Memphis are more significant than those at New

Orleans, for Vicksburg and Memphis are located on the loess, and, moreover, the directions at New Orleans are complicated by local land and sea breezes which do not extend far inland. It will be seen that the prevailing winds at New Orleans and Vicksburg are

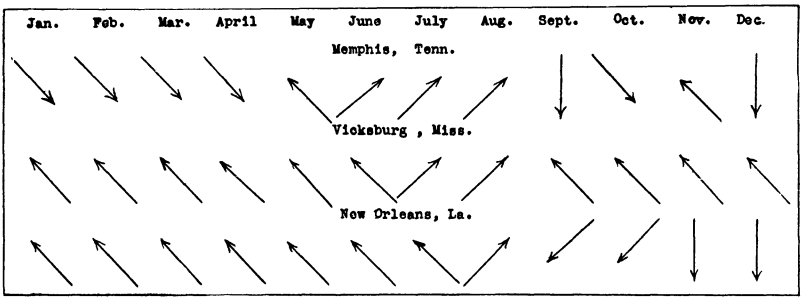

FIG. 3.—Diagram showing the directions of prevailing winds at New Orleans, Louisiana, Vicksburg, Mississippi, and Memphis, Tennessee. (Data from *Bulletin Q*, by A. J. Henry, U.S. Weather Bureau, 1906.)

southerly, and probably would account for the greater accumulation of loess at the southern ends of Avoyelles Prairie and Sicily Island. On the other hand the easterly winds greatly exceed those from westerly directions, except at Memphis, where the westerly

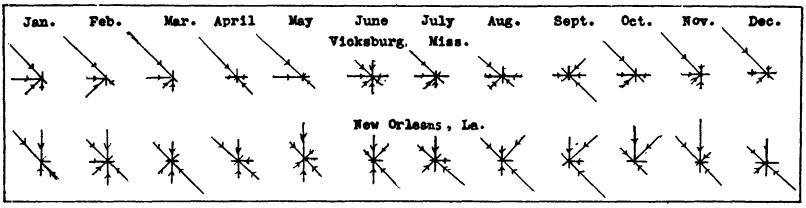

FIG. 4.—Diagram showing the occurrences of high winds at New Orleans, Louisiana, and Vicksburg, Mississippi. Lengths of arrows are proportional to frequency. (After data by I. M. Cline, of the U.S. Weather Bureau at New Orleans, and W. E. Barron, of the U.S. Weather Bureau at Vicksburg.)

winds predominate. Fig. 4 shows the frequency of high winds at New Orleans and Vicksburg. At New Orleans about 26 per cent of high winds are from easterly directions, 17 per cent from westerly directions, 32 per cent from northerly directions, and 25 per cent from southerly directions. At Vicksburg 29 per cent of high winds

are from northerly directions, 16 per cent from southerly directions, 11 per cent from easterly directions, and 43 per cent from westerly directions. It should be noted that only the highest winds are included in the data given above. Undoubtedly the high winds are effective dust carriers, but loess is so fine grained that it could doubtless be carried by ordinary winds, other things being favorable. Fig. 3, which shows the winds of all velocities, probably is more significant than Fig. 4, which shows only a part of the high winds. Remembering the much greater thickness and width of the eastern loess belt, it would seem that the present winds would not be competent to account for the disparity between the eastern and western loess belts. This is certainly true so far as occurrences are concerned, and there is no reason to believe that either the persistence or velocity of winds from any one direction are especially notable. During loess-depositing times westerly winds must have been more predominant than at present. The present southerly winds would seem to be competent to deposit the greater thickness of loess at Avoyelles Prairie and Sicily Island. Obviously more observations of loess thickness on isolated areas are needed before positive conclusions can be drawn as to the efficiency of southerly winds.

SUMMARY

(1) The greater efficiency of westerly winds in the southern loess belts is shown by (*a*) the greater width and thickness of the eastern loess belt and (*b*) by the higher percentages of lime, potash, and phosphoric acid of the soils of the western belt. (2) The greater thickness of loess on the southern sides of two isolated loess areas indicates that southerly winds were more efficient in this region than northerly winds. (3) From the meager data available it would seem that westerly winds were more frequent and effectual in loess-depositing times than at present.